



Investigation and Evaluation of the Effect to Environmental Pollution of Plastic Shopping Bags

Sevgi Güneş DURAK

Nevşehir Hacı Bektaş Veli University, Faculty of Engineering - Architecture, Environmental Engineering Department, 50300, Nevşehir, Turkey

*Corresponding Author:

E-mail:ssevgigunes@gmail.com

Received: June 13, 2016

Accepted: September 19, 2016

Abstract

Shopping which is related to the level of economic development, except for consumption necessities such as eating-drinking-dressing, is taken up a wide space extremely in today's conditions. By increasing in the number of shopping, environmental pollution increases, too. Plastic bags (shopping bags) used in shopping have a duration of extinction in the nature 400-1000 years, during this time, plastic bags enter the food web and are toxic for human and other livings as a soil pollutant; cause the death of marine and by increasing anaerobic conditions as a water pollutant; and in the form of biodegradable plastic bags emit marginally more carbon dioxide (CO₂ - a greenhouse gas) as they decompose as an air pollutant, shows that plastic bags are a serious pollutant.

It is estimated that about 100 billion plastic bags and 10 billion paper shopping bags are used each year only in the United States; Local and State Governments around Australia spend more than \$200 million per year picking up litter. Some plastic bags are produced as biodegradable. But they cannot exist completely and photodegrade - breaking down into smaller and smaller toxic bits contaminating soil and waterways and entering the food web. Paper bags are alternative to plastic bags, but in the producing, require three times the energy over their life cycle as compared with plastic bags. It is estimated that each year approximately 14 million trees are destroyed to produce paper bags for consumers. In this study, the plastic bags, their impacts to environment, solution proposals and alternatives were investigated and evaluated.

Keywords: Environmental pollution, Plastic bags, Shopping bags

INTRODUCTION

The word plastic itself comes from the Greek word "Plasticos", which means to be able to be shaped or moulded by heat. As we will see, shaping plastics by using heat is a basic part of nearly all plastics manufacturing processes [1]. Plastics are derived from organic products. The materials used in the production of plastics are natural products such as cellulose, coal, natural gas, salt and, of course, crude oil. Crude oil is a complex mixture of thousands of compounds. To become useful, it must be processed [2]. In case most plastic carrier bags are made from polyethylene, a kind of plastic. High Density Poly Ethylene - HDPE- is used to make supermarket type carrier bags. Low Density Poly Ethylene - LDPE- used to make soft clear bags like the ones used for packing of vegetables, toys and clothes. Biaxially oriented polypropylene -BOPP- is the crisp crystal clear stuff used for greeting cards, the plastic wrapping round boxes of tea etc. and food packs like pasta [3]. Even the design promotes its attractiveness to consumers-lightweight, portable, functional, cheap, then easily discarded; it is these features that facilitates to the problems and impacts associated with their use. Since PSB are not fundamentally packaging items in themselves, they do not affect the character of the physical product, making them non-essential to the product, but rather acting as a carrying aide [4]. Plastic bags are made from fossil fuels and their production requires the energy equivalent of burning 12 million barrels of oil each year [5]. This amount of emissions is equivalent to the emissions generated annually from 1009530 passenger vehicles and 5158000 metric tons of carbon dioxide emissions are occurred to produce these bags.

4% of Crude oil is used for plastic production and 3% of the plastics are used for the production of plastic bags. The average weight of a plastic bag is 6 grams, and its footprint

is 0,06 m² [6]. Plastic bags are provided as the last stage in the packaging mix. Packaging plays an important function of protecting and preventing spoilage of food and goods [7].

Plastic bags were first introduced into the market place in 1974. At this time Montgomery Ward, Sears, and J.C. Penny all switched their shopping bags to plastic. By 1977, supermarkets began offering plastic bags to shoppers and asking the question, "Paper or Plastic?" [5].

Plastic bags are commonly used for outdoor activities as picnic, sports etc. They are often brought home and used again.

Worldwide, a trillion single-use plastic bags are used each year, nearly 2 million each minute. The amount of energy required to make 12 plastic bags could drive a car for a mile [8]. Also, plastic bags which are used for a very short time, are decomposed in the nature for hundreds of years.

The Effects of Plastic Bags

The problem with PSB can be characterized by two factors: (1) environmental impacts, and (2) impacts on society. Environmental impacts range from litter, to a danger to wildlife, to the use of non-renewable resources. Societal use of PSB creates an unnecessary consumption of an unsustainable product, while provided at no visible cost to the consumer. Consumption of plastic bags are leading to unsustainable development with serious economic, social, and environmental repercussions. As PSB are tangible (compared to climate change, which is intangible), they are visible reminders of our unsustainable consumption and use [9].

The environmental effects of plastics have been investigated since 1970s and the new discoveries are still being. Research is presenting alarming results as to the disruption of reproduction and behaviours of animals, food chains and ecosystem functions. Compounding these impacts

is the fact that plastic is used heavily in the packaging mix and is the most common item found littered [7].

Each plastic bag, threatening the natural habitat causes the termination of life. Because livestock choking on plastic bags—from camels in the United Arab Emirates to sheep in Mauritania and cattle in India and Texas—have led communities to consider regulation. Currently 100 billion plastic bags pass through the hands of U.S. consumers every year—almost one bag per person each day. Laid end-to-end, they could circle the equator 1,330 times [8]. The indefinite period of time that it takes for the average plastic bag to breakdown can be literally hundreds of years. Every bag that ends up in the woodlands of the country threatens the natural progression of wildlife. Because the breakdown rate is so slow the chances that the bag will harmlessly go away are extremely slim. Throughout the world plastic bags are responsible for suffocation deaths of woodland animals as well as inhibiting soil nutrients. The land litter that is made up of plastic bags has the potential to kill over and over again. It has been estimated that one bag has the potential to unintentionally kill one animal per every three months due to unintentional digestion or inhalation. If you consider the number of littered plastic bags ranges from 1.5 million to 3 million depending on location, this equals a lot of ecosystem sustaining lives lost. Without the balance of the ecosystem food sources dry up and starvation occurs. With an increase in plastic bag use throughout the world, the eventual effects could be literally devastating even to the human population. [10].

Large amounts of plastic bags, styrofoams, rubbers, fishing lines and other hard-to-degrade plastic materials collect in the marine environment and may float for decades estimated that between 60 and 80% of all marine debris is plastic polymer-based. The source of this plastic debris is both land and sea-based. It has been estimated that ocean going vessels dispose of between 4 and 6.5 million metric tons of plastic each year. Marine debris has become a growing hazard for many marine animals. They mistake the plastic for natural prey items, ingesting it or becoming entangled within the rubbish, which reduces the overall fitness of the animal. It is estimated that plastic debris affects 267 species worldwide, including 86% of all sea turtles, up to 36% of seabirds, and up to 28% of all marine mammals. It is hypothesized that sea turtles have been impacted more heavily than other marine species as they have well-developed downward facing, keratinized papillae in their oesophagus. The presumed function of these papillae is to trap food, while excess water is expelled prior to swallowing. This well-developed anatomical feature inhibits regurgitation and increases the probability that swallowed plastics remain within the digestive tract, causing gut impactions and/or perforations [11]. The ingestion of plastics reduces feeding stimulus, hinders fat deposits, effecting migration and breeding, gastric enzyme secretion, lower steroid hormone levels, delayed ovulation and reproductive failure [7].

Regulations in the World for Prevent Using Plastic Bags

Over the last century, plastic has taken over the planet. On the one hand, plastic seems a miracle material, with beneficial uses ranging from medical devices to making vehicles lighter and more fuel-efficient. On the other hand, it is a curse, allowing for the seemingly cheap mass production of disposable materials that fill up landfills, cloud the oceans, choke wildlife, and sully vistas. Filled with additives that

lack a safety record, plastics have been linked with a slew of health concerns, including certain types of cancer and infertility. While plastics can be used and recycled wisely, the majority of those produced are neither. Perhaps no other item symbolizes the problems of our throwaway culture more than the single-use plastic bag. Given the multitude of problems associated with plastic bags, many communities around the world have attempted to free themselves from their addictions by implementing bag bans or fees. The oldest existing bag tax is in Denmark. Passed in 1993, this regulation affected plastic bag makers who paid a tax based on the bag's weight. Stores were allowed to pass the cost on to consumers either in bag charges or absorbed into the prices of other items. The initial effect of this system was an impressive 60 percent drop in plastic bag use.

- The oldest existing plastic bag tax is in Denmark, passed in 1993. Danes use very few light-weight single-use plastic bags: about 4 per person each year.
- Many European countries tax plastic bags or ban free distribution. The EU Parliament is discussing measures that could require member states to cut plastic bag use by 80 percent by 2019. A memo on the proposal noted that “plastic bags have been found in stomachs of several endangered marine species,” including various turtles and porpoises, and 94 percent of North Sea birds [12].
- Plastic bag ban is in France passed in 2010.
- One of the most well-known bag measures is Ireland's national bag tax, adopted in 2002. It was the first to charge consumers directly, starting at a rate of 15 euro cents (20¢) per bag. Within five months of the measure's introduction, bag usage fell by over 90 percent. Litter was greatly reduced as well [12].
- USA government imposed recycling obligation to stores that have minimum 5000 m² area or have more than 5 branches. Plastic bags that don't recycle were banned. It is obligated to write “Please bring back this plastic bag for recycling”.
- The provinces of Ontario and Quebec have each halved their plastic bag use through a variety of measures, including store incentives for using reusable bags and retailer-imposed fees.
- Over 150 U.S. cities and counties ban or require fees for plastic bags. California passed the first statewide ban in 2014, though Hawaii had a de facto ban through county ordinances. Over 49 million Americans live in communities that have passed plastic bag bans or fees.
- U.S. cities with bag bans include San Francisco (as of 2007), Portland (2011), Seattle (2012), Austin (2013), Los Angeles (2014), Dallas (to begin in 2015), and Chicago (2015).
- Australia banned plastic bags.
- In China, plastic bags were banned in 2008 and the ban prohibits shops, supermarkets, and sales outlets from handing out free plastic bags and bans the production, sale, and use of ultra-thin plastic bags under 0.025 millimeters thick.
- In 2002, India especially New Delhi and Bombay banned the production of plastic bags below 20 µm in thickness to prevent plastic bags from clogging of the municipal drainage systems and to prevent the cows of India ingesting plastic bags as they confuse it for food.
- In January 2003, Taiwan banned the free distribution of lightweight plastic bags.
- At least 16 African countries (Kenya, South Africa, Uganda, Rwanda etc.) have announced bans on certain types

of plastic bags, to varying levels of effectiveness. Before a ban on thin bags-which tear readily and get caught by the wind-went into effect in 2003, plastic bags were christened South Africa’s “national flower” because of their prevalence in bushes and trees.

- The plastics industry has spent millions of dollars to challenge plastic bag ordinances [8].

Alternatives

Degradable Bags, Paper Bags and Reusable Bags

In 1852 Francis Wolle patented in the United States, and later in France and England, a machine that he devised for making paper bags. It was the first of its kind, and covers the fundamental principle of the many similar machines that are now used. These paper shopping bags were originally sold to customers for a small fee but as manufacturing of bags became less expensive, the bags were eventually given away free to encourage shoppers to purchase more goods [5].

Commonly paper bags are recommended as an environmentally friendly alternative to PSB. It is suggested the natural fibres of paper and its “recyclability” creates a positive image of paper bags. However, the impacts of milling trees and processes used to make, and recycle, paper are often not taken into consideration. Currently the most popular alternative to traditional PSB is biodegradable or “bio-plastic” bags. Biodegradable bags or bio-plastic bags have the same positive image of natural fibres and degradability as paper. However, there are many types of degradable and biodegradable plastics and not all are without environmental impact. The same can be said about reusable alternative to PSB. As a result of these perceptions, many alternatives to PSB suggested have equal if not more damaging environmental impacts than PSB. Therefore alternatives to PSB have to be assessed for environmental and social impacts across their potential life cycles, or a life cycle analysis (LCA) before they can be recommended. The system boundary can include: raw materials and their extraction to finished product, (cradle to gate); from raw materials to the disposal or recycling of materials (cradle to cradle); from raw materials to disposal (cradle to grave); or can focus on one aspect of an objects life, such as the manufacture of a product (gate to gate) (Figure 1) [7].

In addition to Life Cycle Analysis, when deciding on the type of bag to be used as well as the carbon footprint is one of the parameters to be taken into consideration. As it is known a carbon footprint is defined as “the total set of greenhouse gas emissions caused by an expressed as CO2. Until recently, the primary debate has been over paper versus plastic bags.

With the increase in popularity over bags which are designed to be reusable, the next question people are asking is: “What is the relative carbon footprint of paper, plastic, and re-usable bags.” The UK government’s Environment Agency released a longawaited report in February that says single-use polyethylene grocery bags have a lower carbon footprint than alternative paper or reusable bags unless the alternatives are reused multiple times. “Lightweight single-use carrier bags have the lowest carbon footprint per bag based primarily on resource use and production,” the agency said. “Paper, heavyweight plastic and cotton bags all use more resources and energy in their production. A key issue, however, is how many times bags are reused.” [5].

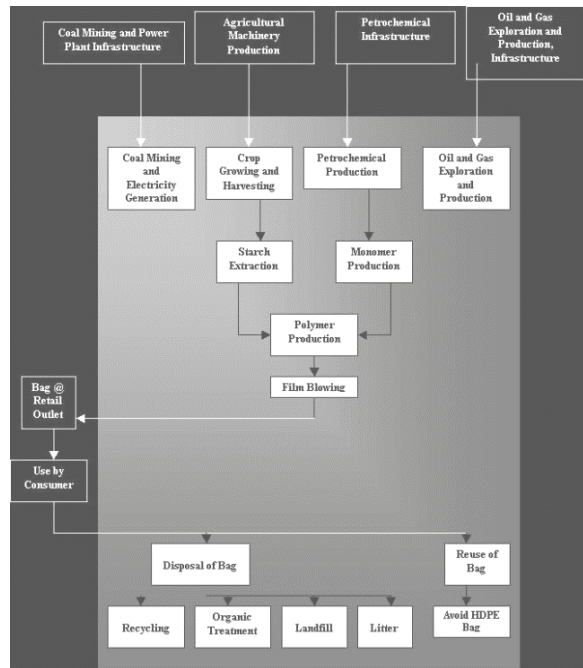


Figure 1. LCA system boundaries [7].

The category of biodegradable bags incorporates many classes of natural starch based plastics, synthetic degradable plastics and blended synthetic and natural plastics, with different environmental impacts from each type. In contrast, paper is made with one format, although different grades, colours and thickness and alter the environmental impacts of production and use. Finally, reusable bags can be made from both renewable and non-renewable sources, including different types and applications of plastics and cloth [7]. A disadvantage of biodegradable bags do not degrade completely, separate into small pieces and entered to food web in a more effective manner.

International research demonstrates that the environmental impacts of all bags are: energy use; water use; water pollution; air pollution, 183 solid waste productions; littering. The classification of biodegradable plastics is given in Table 1 [7]:

Table 1. Classification of biodegradable plastics

Degradation Type	Material	Degradation Mechanism
Environmentally Degradable	Traditional hydrocarbon based plastics	Breaks down into polymers due to natural forces such as water, light and oxygen
Natural Degradable	Plastics made from starches and renewable sources	Breaks down via biological organisms to only naturally occurring molecules (water carbon dioxide and methane)
Synthetic Degradable	Plastics made from non-renewable source, oil, and are biodegradable	Breaks down via biological organisms to plastic particles
Blended Degradable	Plastic blend of natural and synthetic biodegradable resin	Breaks down via biological organisms to naturally occurring molecules and plastic particles

The growth of trees for paper production includes the impacts of land control, fertiliser and water use. On the other hand, the growing of trees is renewable resource and provides a carbon sink, in some cases providing a tool for offsetting carbon use, gaining carbon credits in emissions trading systems. However the subsequent milling of trees to make pulp and paper removes a carbon sink and contributes to land degradation, ecosystem damage, fuel use, and carbon emissions from transportation and machinery [7].

The production and use of paper bags have an energy use of 1,344 kilojoules, compares to polythene PSB energy consumption of 1,047 kilojoules and a reusable bag's 120 kilojoules. More recent studies suggest paper bags consume similar amounts of energy as traditional plastic bags. However the total production, use and disposal of paper bags is estimated to: use three times the amount of water; produce

ninety-percent more green house gases; eighty-percent more nitrogen oxides and sulphur dioxides emissions; twelve times the nitrate and phosphate pollution to water; and produce eighty-percent more solid waste, than traditional PSB [7]. Both paper and plastic bags are recyclable and it is estimated that 17 BTU's are required to recycle each plastic bag and 1444 BTU's are required to recycle each paper bag. In the case of plastic bags, demand has risen for recycled resin because it is less expensive to use recycled plastic resin than virgin resins. Plastic bag recyclers can earn 15-20 cents per each pound of plastic bags recovered [5]. The routes of plastic bags use and disposal is given in Figure 2 [14].

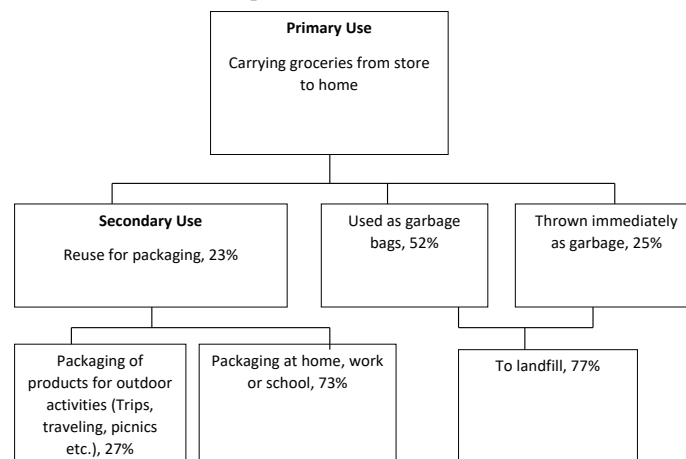


Figure 2. The routes of plastic bags use and disposal, calculated from the survey

RESULTS and DISCUSSIONS

Production and consumption of plastic bags is too much and its annual recycled rate is only %1. The rest of it mixes to water, soil and, air as CO₂ emission during decomposition. When investigated the environmental impact of plastic bags, it has been identified as a serious threat to all living beings in water, soil and air.

Some countries in the world have taken precaution such as taxation, pricing and prohibition. Also in India, Plastic Waste Management Rules 2016 has been published. Australia and the European Commission are working on plastic waste.

As the basis of the precaution, taken and measures to prohibit the regulation at a global level may be obligated to comply with these regulations. For example, the engagements that regulate as for other wastes, the framework defined by result of conferences, member country policy could be taken. Sanctions could be apply to the countries that do not comply with contract terms and have not reached the designated goals. In addition to the proposal achieved in long term, in short term the following suggestions could be carried out.

1. Incentives can be paid to dealers by the government by controlling buying and consumption plastic bag in case of low plastic bag consumption.

2. By giving education to small children adopted by the losses of plastic bags, not to use plastic bags can be turned into a way of life.

3. Public interest factors can be combined with (food, small gifts, etc.) can be educated through such activities as seminars.

4. Plastic bags collected back and small awards can be given for a certain amount by municipalities.

5. Recycling and waste plan can be created in the field, if required deposit can be given to customers as incentive.

6. Consumers should be encouraged to reusable bags. For example, generally ladies go shopping, so a fad created among them by different styles and types of reusable bags are designed in attractive colors also can be reduced the use of plastic bags. Especially, rich people are oblivious to price of these bags. In addition, young people can be encouraged to use these bags with famous people.

7. Ensuring control on production and energy consumption, considering the amount of CO₂ emissions of plastic bags, biodegradable and/or organic bags can be produced. For example, in terms of CO₂ emissions, for disposable biodegradable bags starch based PE bags (4,74 kg CO₂), for disposable plastic bags HDPE bags (6,13 kg CO₂), and for reusable durable bags HDPE woven bags (0,63 kg CO₂ – 2 years, 104 times) may be preferred.

8. Consumers can be educated with posters and billboards in markets, shopping centres etc.

9. People can be awareness by indicating the harmful effects of plastic bags on TV and radio with public spots. So, they do not prefer or less prefer plastic bags.

If you prefer reusable bags instead of plastic bags, per week 6, per month 24, per year 288 and in our avarege life 22176 plastic bags will not have to be used. For all the world, in our life one in five people do this, 26.611.200.000.000 plastic bags do not mix to nature.

This world is not us and it entrusted to us. We must live

carefully for not to take away right to life living beings now and tomorrow, and we never recklessly. A living being's freedom ends where another living being's freedom begins.

REFERENCES

- [1] An Introduction to Plastics-A textbook for secondary schools. 2015. <http://plasticquarian.com/wp-content/uploads/2015/06/plasticbook.pdf>.
- [2] Plastics Europe. 2016. <http://www.plasticseurope.org/what-is-plastic/how-plastic-is-made.aspx>
- [3] A guide to living plasticless. 2008. <http://plasticisrubbish.com/2008/03/28/what-are-plastic-bags-made-from/>
- [4] Allen Consulting Group. 2006. The ANRA Proposal on plastic bag management: supplementary economic analysis to the EPHC report.
- [5] City of Evanston, Office of Sustainability. 2011. An overview of shopping bags in Evanston developed.
- [6] PAGEV, Turkish Plastics Industry Foundation. 2016. www.pagev.org.tr/admin/pics/dosyalar/alphan-erozturksunum.pdf.
- [7] Tough, R., 2007. Plastic bags:environmental impacts and policy options, MSc. Thesis, School of Geography, Environment and Earth Sciences Victoria University of Wellington.
- [8] Earth Policy Institute. 2016. www.earth-policy.org.
- [9] Miller R M. 2012. Plastic bags: An analysis of policy instruments for plastic bag reduction, MSc.Thesis, Universiteit Utrecht.
- [10] Health Guidance. 2016. <http://www.healthguidance.org/entry/14901/1/The-Effects-of-Plastic-Bags-on-Environment.html>.
- [11] Müller C, Townsend K, Matschullat J. 2012. Experimental degradation of polymer shopping bags (standard and degradable plastic, and biodegradable) in the gastrointestinal fluids of sea turtles, Science of The Total Environment. 416: 464-467.
- [12] Larsen J, Venkova S. 2014. The downfall of the plastic bag: A global picture, Earth Policy Institute-2014, Providing a plan to save civilization.
- [13] Cevreonline. 2016. <http://cevreonline.com/plastiklerin-kullanimi-ve-tehlikeleri/>
- [14] Ayalon O, Goldrath T, Rosenthal G, Grossman M. 2009. Reduction of plastic carrier bag use: an analysis of alternatives in Israel, Waste Management 29: 2025-2032.